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*Published in:*
Book of Abstracts. DTU's Sustain Conference 2015

*Publication date:*
2015

*Document Version*
Publisher's PDF, also known as Version of record

# Hydrogen mediated biogas upgrading in a two-stage mesophilic reactor

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In this study, biogas upgrading was tested in an innovative two-stage mesophilic reactor, where the $CO_2$ in the biogas was coupled with external $H_2$ and converted into $CH_4$ by hydrogenotrophic methanogenesis. The first stage was responsible for the most of the biogas produced, while in the second one, where the $H_2$ was injected, the $CO_2$ was converted to $CH_4$ (Fig 1). Prior to the $H_2$ addition, the biogas was composed by 70% $CH_4$ and 30% $CO_2$. On the contrary, upon $H_2$ addition, the $CO_2$ content decreased to 9% upgrading the biogas to 89% $CH_4$ (Fig 2). Archaeal population increased to approximately the half of the total community. The increase of hydrogenotrophic methanogens, with Methanoculleus as dominant genus, and syntrophic bacteria and the decrease of aceticlastic methanogens and fermentative bacteria assert the selective pressure of the $H_2$ toward the hydrogenotrophic pathway, enhancing the $CO_2$ consumption and thus the biogas upgrading. Moreover, in absence of aceticlastic methanogenesis, acetate was likely degraded via syntrophic acetate oxidation with hydrogenotrophic methanogens, by bacterial groups such as Thermoanaerobacteraceae (1).

**Fig 1:** Two-stage reactor configuration.

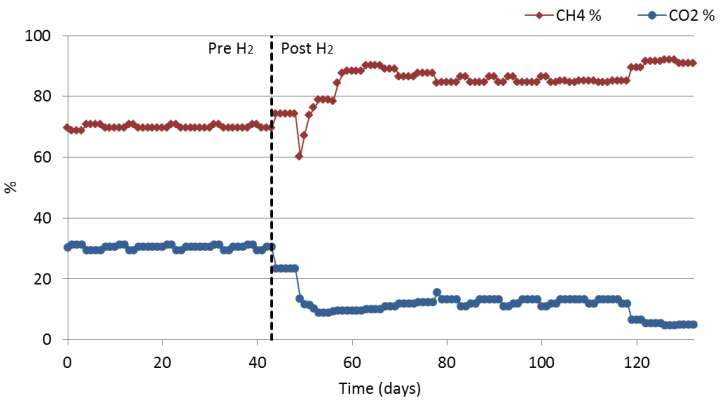


**Fig 2:** Biogas composition prior and after the $H_2$ addition.

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1. Lü et al. Metaproteomics of cellulose methanisation under thermophilic conditions reveals a surprisingly high proteolytic activity. ISME J. **2014**, 8 (1), 88–102.